Based on the harmonic measurement of three frequency transceiver integrated microstrip antenna

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***Abstract*—Based on harmonic measurement, the paper designs one transmitting two receiving triple frequency microstrip antenna respectively working at 2.4 GHz and 4.8 GHz, 7.2 GHz bands. The two high frequency antennas are placed side by side at the top of the low frequency bands antennas, which can realize low frequency bands antennas transmit electromagnetic wave and two high frequency antennas receive reflected wave.**

Key Words: Harmonic measurement, Triple frequency bands, Transmitting and receiving antenna, Double- layer

I. INTRODUCTION

In recent years, the studies based on microwave measurement, microwave imaging and other similar directions become more popular applications. Harmonic measurement uses nonlinear objectives under microwave radiation generating new frequency components to judge, identify and detect the target. After measurement, when transmitting the 2.4GHz frequency to the nonlinear object (such as the semiconductor device), the resonant frequency is near 7.2GHz and 4.8GHz frequency.

Taking into account the portability and complex environment of the detection device, the designed antenna should select microstrip antenna with the characteristics of small volume and shape stability and so on. In addition, microstrip antenna also has the advantages of light weight, low cost, easy integration [1-3], etc.

The paper based on harmonic measurement design tri-frequency antenna. In order to make the antenna can transmit and receive simultaneously without interfering with each other, and improve efficiency, the designed antenna uses every frequency antenna to feed respectively [4-7].

II. ANTENNA DESIGN

There are many ways to realize multi-frequency operation mode of antenna [8-12]:1. Multi-layer patch overlap. It mainly makes antenna working in different frequency bands stack together to realize multi -frequency working modes; 2. Multi-mode loading. It refers to change the position of the feed point to produce the two different work modes on the patch, so as to excite dual frequency; 3. Reactance loading .It refers to slot in the patch to produce electromagnetic disturbance so as to realize multi-frequency. After comprehensive comparison, the design chooses the mode of cascade feeding respectively.

In theory, we can use the transmission line model to analyze its performance. The length of the radiating patch is L, the width of the radiating patch is W, the thickness of the dielectric plate is h, the relative permittivity of the Dielectric constant is ε_r . Assuming that the central frequency of F, the thickness of the dielectric plate h, the relative permittivity of Dielectric constant ε_r are known.

Wavelength in vacuum:

$$\lambda_0 = \frac{c}{f} \quad (1)$$

Medium wavelength:

$$\lambda_g = \frac{\lambda_0}{\sqrt{\varepsilon_r}} \quad (2)$$

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Effective Dielectric constant:

$$\varepsilon_e = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + \frac{10h}{W}\right)^{-1/2} \quad (3)$$

Substrate equivalent extension length:

$$\Delta l = 0.412h \frac{(\varepsilon_r + 0.3)\left(W/_h + 0.264\right)}{(\varepsilon_r - 0.258)\left(W/_h + 0.8\right)} \quad (4)$$

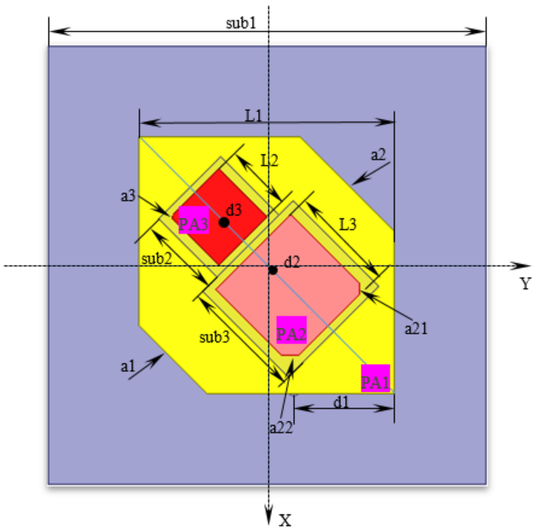
Rectangular patch length:

$$L = \frac{\lambda_g}{2} - \Delta l \quad (5)$$

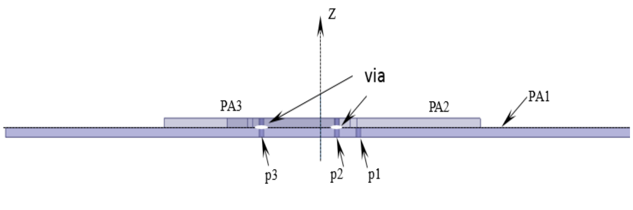
Rectangular patch width:

$$W \leq \frac{c}{2f}\left(\frac{\varepsilon_r + 1}{2}\right)^{-1/2} \quad (6)$$

In the formula, C is the speed of light and F is the working frequency of the antenna.



(a)



(b)

Fig. 1. Antenna model. (a) top view; (b) cross-sectional view

The geometrical structure of the antenna is shown in Figure 1. The antenna is composed of two layers, the upper layer is two independent patch units, and the two layers use the same substrate material, RO4350 Rogers. Its dielectric constant is 3.48 and thickness is 0.76mm. The antenna in the way of feeding respectively maintains the independence of every frequency and is easy to adjust the matching.

Through the port 1 feeding the lower layer of the patch, the lower layer radiates electromagnetic wave. Electromagnetic wave beating the nonlinear device reflects electromagnetic wave, and then through the upper two antennas to receive the wave. The port 2, 3 transmit received signals to the system signal processing unit to judge and feed.

The initial size of the antenna is obtained by theoretical calculation, showed in Table 1.

TABLE I. Antenna theory for calculating the dimensions (mm)

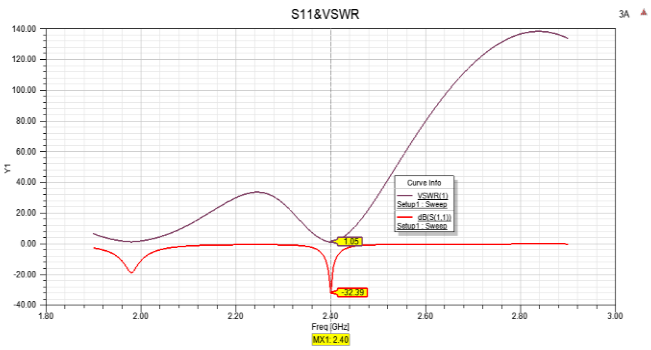
sub1	sub2	sub3	L1	L2	L3
65	18.4	12.5	39	15.6	10.2
a1	**a2**	**a21**	**a22**	**a3**	**d1**
10.1	14	2.5	0.7	0.5	4
d2	**d3**				
2.5	1.6				

Wherein the distance between d2 and d3 in the oblique axis is relative to the center of PA3 and PA2.

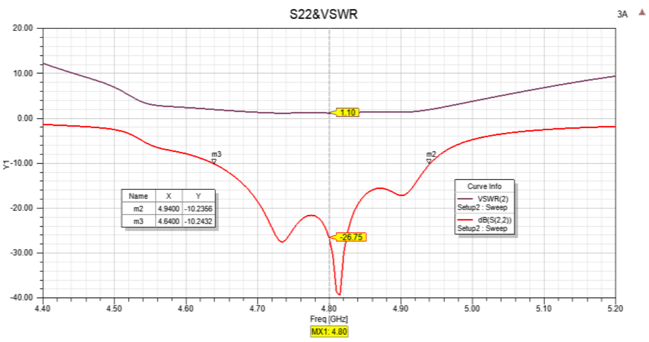
III. RESULTS AND DISCUSSION

From the simulation results of Figure 2-1, S11 of the antenna working in the 2.4GHz, 4.8GHz, 7.2GHz is more than-20dB, which is better if matched in Smith Chart.

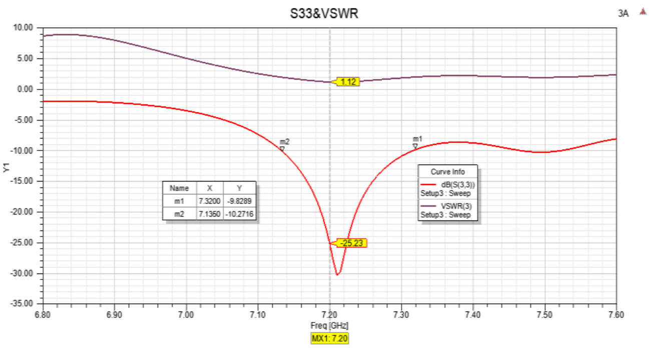
The antenna gains of Figure 2-3 are 3.5dB, 4.9dB, and 5.0dB respectively. In terms of theoretical simulation, the performance of the antenna has met the requirements.



(a)



(b)



(c)

Fig. 2-1 S11&VSWR. (a) 2.4GHz; (b) 4.8GHz; (c) 7.2GHz.

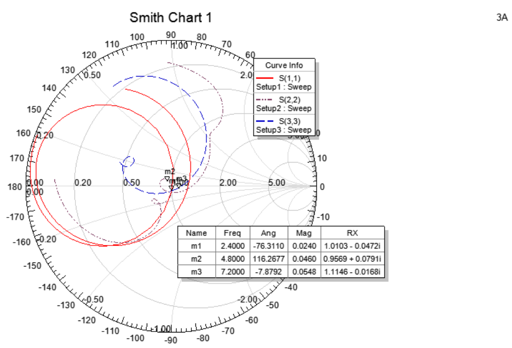


Fig. 2-2 Smith Chart

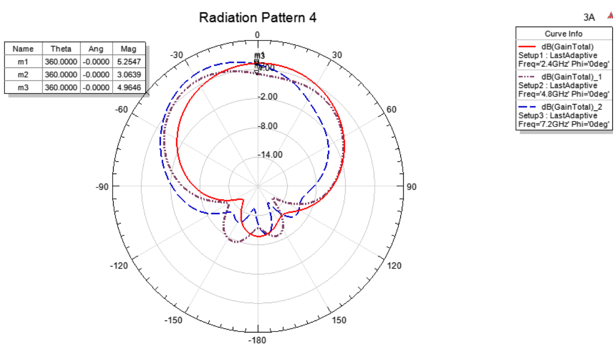


Fig. 2-3 Radiation Pattern

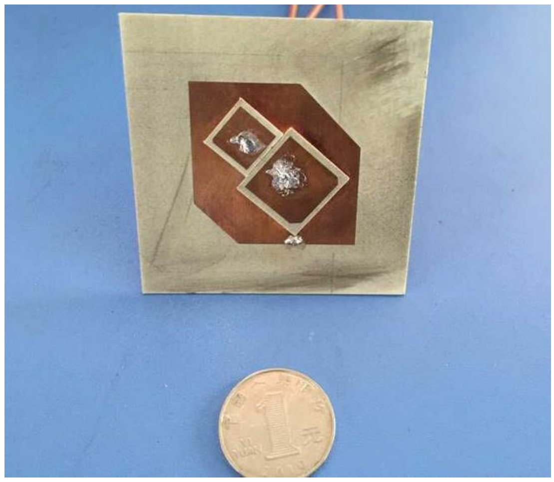
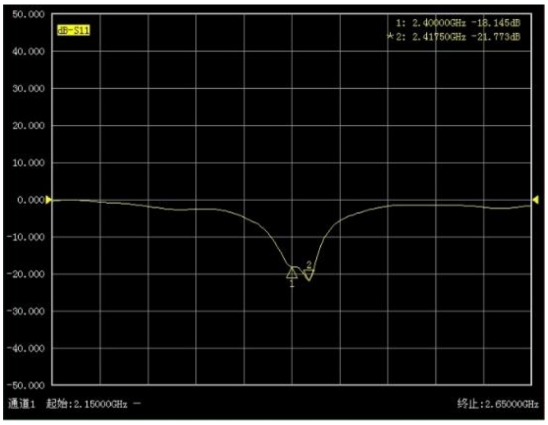


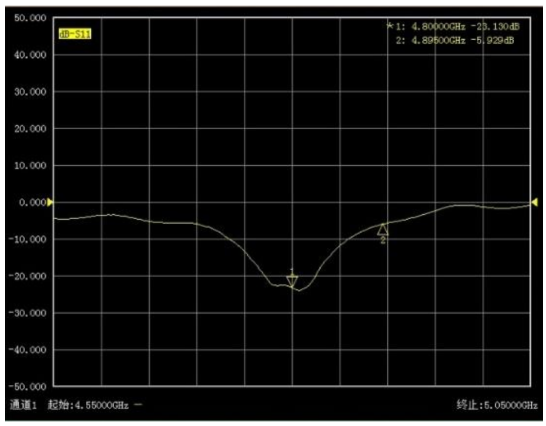
Fig. 2-4 Processed Antenna

Vector network analysis instrument used in physical test is Agilent E5071C.

Figure 2-4 is the processed antenna. The results of the antenna S11 in the Figure2-5 can be achieved under the -15dB and work well.



(a)



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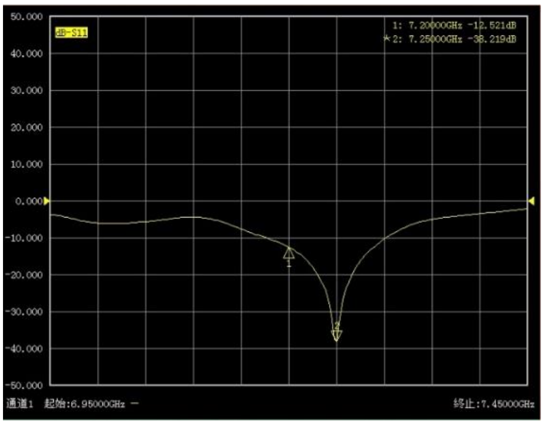

(c)

Fig. 2-4 measurement S11. (a) 2.4GHz; (b) 4.8GHz; (c) 7.2GHz.

IV. CONCLUSION

Based on harmonic measurement, the paper designs cascade triple frequency microstrip antenna meeting the work index of the antenna. Feeding every antenna respectively to ensure the independence of every antenna, and realize the transmitting and receiving simultaneously without interfering with each other. The antenna structure is simple and controllable. It is easy to realize, its gain is higher, and has the very good value of use.

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